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# Random lattice deformations in rare-earth-doped cubic hexafluoroelpasolites: High-resolution optical spectroscopy and theoretical studies

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## Abstract

High-resolution Fourier spectroscopy is used to study the low-temperature (3-10 K) optical absorption spectra of $Cs_2NaYF_6$ and $Cs_2NaScF_6$ crystals doped with rare-earth ions, which substitute for $Y^{3+}$ or $Sc^{3+}$ ions at sites with cubic $O_h$ symmetry. Splitting of some absorption lines corresponding to doublet ($\Gamma_6$ or $\Gamma_7$)-quadruplet ($\Gamma_8$) transitions in the Kramers $Yb^{3+}$, $Er^{3+}$, and $Sm^{3+}$ ions and a singlet ($\Gamma_1$)- triplet ($\Gamma_4$) transition in the non-Kramers $Tm^{3+}$ ion is observed. In the vicinity of these lines, additional spectral satellites with intensities depending nonlinearly on the concentration of the rare-earth ions are present. We argue that the observed splitting is caused by low-symmetry components of the crystal field induced by random lattice strains. An explicit expression for the generalized distribution function of local strains produced by random point defects in the elastic continuum is derived and used to simulate the line shapes. A satisfactorily agreement with the measured spectra is achieved. The observed satellite transitions are ascribed to pairs of the nearest-neighbor rare-earth ions interacting through the dynamic lattice deformations. © 2012 American Physical Society.

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